LETTUCE (*Lactuca sativa* L.) PRODUCTION IN RECIRCULATING HYDROPONIC SYSTEM EQUIPPED WITH THERMO-ELECTRIC COOLER

CLAIRE D. PARAYNO

An Undergraduate Thesis Submitted to the Faculty of the Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines in Partial Fulfillment of the Requirements for the Degree

BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
(Land and Water Resources Engineering)

JUNE 2019

ACCEPTANCE SHEET

This undergraduate thesis entitled, **"LETTUCE (*Lactuca sativa* L.) PRODUCTION IN RECIRCULATING HYDROPONIC SYSTEM EQUIPPED WITH THERMO-ELECTRIC COOLER,"** prepared and submitted by **CLAIRE D. PARAYNO,** in partial fulfillment of the requirements for the degree **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (Land and Water Resources Engineering)**, is hereby accepted:

RUEL G. PENEYRA
Member, Advisory Committee

6/13/19
Date Signed

VITALIANA U. MALAMUG, Ph.D.
Member, Advisory Committee

6/14/19
Date Signed

CHITO F. SACE, Ph.D.
Chairperson, Advisory Committee

6/13/19
Date Signed

Accepted as partial fulfillment of the requirements for the degree **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (LAND AND WATER RESOURCES ENGINEERING)**:

MARVIN M. CINENSE, Ph.D.
Chairperson, Department of Agricultural and Biosystems Engineering

6/14/19
Date Signed

VICTORINO T. TAYLAN, Ph. D.
Dean, College of Engineering

6/14/19
Date Signed

BIOGRAPHICAL SKETCH

The author born on the 6th day of March 1998, is the eldest child of Mr. Rodolfo B. Parayno and Mrs. Purificacion D. Parayno who resides at Sta. Lucia, Victoria, Tarlac. She learns how to overcome challenges in life, live a simple life and put God first.

Her elementary schooling education completed at Victoria West Central Elementary School (VWCES) in 2010. During her schooling, she competed in dancing and other extracurricular activities. After graduation she continued her secondary education at Victoria National High School (VNHS). During her secondary level, she focuses on her study. She graduated on 2014 with an academic distinction.

To pursue her dreams, she continued her tertiary education at Central Luzon State University, Science City of Muñoz, Nueva Ecija. She enrolled Bachelor of Science in Agricultural and Biosystems Engineering major in Land and Water Resources Engineering as her field of specification because of her interest in agriculture. She became a scholar for consecutive five years of CHED-DSWD ESGP-PA. She is also a member of a non-college based student's organization, Kapatirang Plebeians-CLSU Curia.

Her college life was well spent and full of challenging lessons that molded her to became an educated person. She well spent years in building a strong friendship to all the individuals and became her inspiration during ups and downs. In addition, she also spent because the author was able to develop his capabilities to make his dreams possible.

ACKNOWLEDGMENT

The author would like to express his warmest appreciation, deepest gratitude and sincerest thanks to the following people who contributed and helped in making this study successful and contributed in the completion of the study:

the Almighty God, for providing the author a power, spiritual guidance and wisdom to believe in herself in order to pursue her dreams;

Dr. Chito F. Sace, Chairperson of the Advisory Committee, for his guidance, supervision, resources imparted knowledge, and for the continuous encouragement towards the fulfillment of this study;

Prof. Ruel G. Peneyra and Dr. Vitaliana U. Malamug, members of the Advisory Committee, for their time, suggestions and comments for the enhancement of this study;

Engr. Christopher Pascual and Engr. Roldan Quitos, for providing invaluable guidance and assistance throughout this research;

CHED (DSWD), ESGP-PA scholarship, for their very big contribution in her college journey, for the financial support and all the privileges she enjoyed;

Dr. Clarissa Yvonne Domingo, for her unending motivation, prayers and lending the greenhouse used in the study;

Manong June, for his kindness, help and presence during the conduct of the study;

Tita Alma, Alliah, Paulo and Sophia, her second family, for their support which prompted her to finish the study;

Czarina, Ate April, Celine, Kristine, Divine, Krizielle, Melissa and Trisha, her loving dormmates and sisters by heart, for listening to her dramatic stories, for their patience, motivation, and for always being there whenever the author needs them;

Joana, Renz, Alyssa, Cherish, Karlo, Dominic, Ron, Anthony, Art, Krisha BElen her superfriends during college days for their piece of advice, care, untiring effort and support for the success of the author;

Renz C. Hilario her best buddy, for his unlimited motivation, support, advice prayers and understanding to the author to confidently face everyday challenges.

Special acknowledgement to Kim Alexis G. Ramos for his untiring, unconditional love, care, efforts, patience, prayers and inspirational words he shared;

Collene, Cristine, Clark Jester, Chrismark, Cyrus, Chloe and Codee, her siblings and inspiration, one of the reason of the success of the author and for being there no matter what happened.

Virginia M. Damaso, Laureano Damaso, Natividad B. Parayno and Vic Parayno, her grandparents, for their unending prayers, motivations and encouragement;

Mr. Rodolfo B. Parayno and Mrs. Purificacion D. Parayno, her beloved parents, for the inspiration, encouragement, unconditional love, moral, financial support, sacrifice, care, prayers and understanding; and,

those people the author failed to mention, for staying with her in the brightest and darkest days of her life.

To all of them, this humble piece of work is heartily dedicated!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABSTRACT

PARAYNO, CLAIRE DAMASO, Department of Agricultural and Biosystems Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, **June 2019, LETTUCE (*Lactuca sativa* L.) PRODUCTION IN RECIRCULATING HYDROPONIC SYSTEM EQUIPPED WITH THERMOELECTRIC COOLER.**

Adviser: CHITO F. SACE Ph.D.

The study was conducted to determine the performance of thermoelectric cooler in recirculating hydroponic system for lettuce production. The specific aims of the study were: a) to determine the performance of peltier TEC by lowering the temperature of the nutrient solution in a recirculating hydroponic system on lettuce production b) to evaluate the growth performance of lettuce in a recirculating hydroponics system (RHS) fitted with thermoelectric (TEC) nutrient cooler, and c) to evaluate the water consumption and water productivity in RHS with thermoelectric cooler.

Lettuce seeds were directly seeded in growing cups containing the growing media. Environmental and water quality parameters of the systems were observed twice (8:00 am and 2:00 pm) daily to determine the response lettuce. Agronomic characteristics such as plant height and number of leaves, yield, water consumption and water productivity were also measured in the study. The study was subjected to recirculating hydroponic system with and without TEC and was analysed using CRD 2x2 factorial.

Lettuce produce using a RHS with TEC were taller at 17.90cm than grown without TEC at 17.65cm. The number of leaves was recorded the same value of mean of

10 in both systems. The results showed that RHS with TEC gave the higher yield of 1,400 grams compared with the yield of lettuce grown in RHS without TEC.

The total water consumed on the system with cooling was 308L and 322L for system without cooling system. The water productivity in the system with cooling was 4.5g/L and 3.72 g/L on system without cooling system.

LITERATURE CITED

ALLIED BOTANICAL CORPORATION. 2012. Lettuce (*Lactuca sativa*) varieties. Retrieved January 2019 fromhttp://www.alliedbotanical.com/?page_id=98.

ALKABY, R. N. M. 2000. Study of Thermal Performance of Thermoelectric Cooling System. Babylon University Retrieved from www.uobabylon.eduiq

ANDERSON, J.R.1989. Influence of hydroponic culture method on morphology and hydraulic conductivity of roots of honey locust.

BARRY, C. B. 1996. Nutrients: The handbook of hydroponics nutrient solutions. New South Wales, Australia: Casper Publication Pty Ltd.

BRADLEY, F. M. B.W ELLIS & L. DEBORAH, (2009). The Organic Gardener's Handbook of Natural Pest and Disease Control.

BRADLEY, P. 2014. Starting Seedlings in Hydroponics. Retrieved from https://progressive-growth.com

BUCKLIN R.A., 1998. Florida Greenhouse Design. UF IFAS Extension, Gainesville, FL32611.Univerity of Florida. Retrieved on November 2018 from http://ifas.ufl.edu

CAVINS J. pH & EC Meters- Tools for Substrate analysis. NC State University, Floriculture Research

COOK, 2016. US: Lettuce deman increasing as summer starts. Hollandia Poducr at booth #1711 at United Fresh 2016. Chicago

DALPE S., 2002. Pest and Disease Management in Commercial Greenhouse. Agriculture and Forestry. Retrieved on October from https'//www./agric.gov.ab.ca

DEUTSCHMANN, G.V. Sr., 1998. History of Hydroponics. Retrieved on October 2018 from https://archimedesgalilei.com

DOLE J. M. & M.A, SCHNELLE., Greenhouse Structure and Coverings. Retrieved from http;//osufacts.okstate.edu

EDWARDS, J. 2016. History of Hydroponics, Part I: The Beginnings of Water Culture. Retrieved from https://gardenculturemagazin.com

FALL., 2010. Soil PH and Availability of Plant Nutrients. IPNI Plant Nutrition Today-Better Crops Better Environment Through Science. Issue No.2. Page 2. Retrieved on October 2018 from https://www.ipni.net/publication/pnt

na.nsf/0/7F9BC7E6F70685D985257CD60059D00F/$FILE/PNT-2010-Fall-ALL.pdf

GABRIEL A.G., G.A. LORENZO, M.P. PASCUAL, 2018. Vertical Farming Using Farming Using Hydroponic System: Toward A Sustainable Onion Production in Nueva Ecija, Philippines. Open Journal of Ecology,8 125-41 Retrieved from https://doi.org/10.4236/ oje.2018

GIANQUINTO G., N. GRUDA , D.SAVVAS, Y. TUZEL, 2013. Soilless Culture. Good Agriculture Practices for greenhouse vegetable crops. Retrieved from https://www.researchgate.net/publication/255700929

HADFIELD J. 1995. The A-Z of Vegetable Gardening in South Africa. Struikh of Publishers. Cape Town

HANNA INSTRUMENTS. HI 98129-HI 98130 Waterproof pH, EC/TDS & temperature meters, Instruction Manual. This Instrument is in Compliance with CE Directives.

HE, J. & S.K. LEE, (1998). Growth and photosynthetic responses of three aeroponically grown lettuce cultivars (*Lactuca Sativa* L.) to different root zone temperature and growth irradiances under tropical aerial conditions. Journal of Horticultural Sciences and Biotechnology, 73, 173-180.

HE, J. & LEE, S.K. (1998). Growth and photosynthetic characteristics of lettuce *(Lactuca sativa* L.) grown under fluctuating hot ambient temperatures with the manipulation of cool root-zone temperature. Journal of Plant Physiology, 152, 387-391.

HEREDIA,N.A. 2014. Design, Construction and Evaluation of a Vertical Hydroponic Tower. BioResource and Agricultural Engineering BioResource and Agricultural Engineering Department California Polytechnic State University San Luis Obispo

HOPPER E., 2016. Analyzing Nutrient Film Technique. Retrieved on October 2018 from https://www.maximumyield.com/analyzing-nutrient-film-technique/2/1181

ISLAM A. K. M. S., D.G., EDWARDS, & C.J. ASHER, (1979). The role of lime in commercial ginger production in Australia. Fifth Symposium. International Society of Tropical Root Crops. Manila, Philippines.

JENSEN M.H & A. J. MALTER. 1995. Protected Agriculture: A Global Review. World Bank Technical Paper : No. WTP 253 Washington DC : Retrieved on

September from The World Bank.http://documents.worldbank.org/curated/en/170171468765017779/Protected-agriculture-a-global-review

JOHNSON H. JR. 2010, Soilless Culture of Greenhouse Vegetables. UC Davis, VegetableResearch and Information Center. University of California. Retrieved on September from https://vric.ucdavis.edu/pdf/hydroponics_soillessculture of greenhouse%20vegetables.pdf

KULHMANN C., 2015. Hydroponic Systems: Food Security in Developing Countries. Retrieved on October on https://borgenproject.org/simplified-hydroponics-offer-soil-less-food security/.

MARLOW, 2002. Methodological Tools for Assessing Productivity of Water in Agriculture and Interacting Systems With Respect to Tanzania and Ethiopia

MAX M., 2017. 20 Advantages and Disadvantages of Hydroponics that you should know. Retrived from https://www.greenandvibrant.com

MERAR. M, 2015. Investor for Hydroponics Agriculture Project in the Philippines. Industric Technology UK Ltd. Retrieved on October 2018 on https://www.merar.com./meeting

MUÑOZ H. 2010. Hydroponics Home Based Vegetable Production System. Inter-American Institute for Cooperation on Agriculture 2009 annual report: IICA's contribution to the development of agriculture and rural communities in Guyana / IICA – Guyana: IICA, 2010

RESH, 1995. Design, Construction and Evaluation of a Vertical Hydroponic Tower Biosource and Agricultural Engineering Biosource and Agricultural Engineering Department California Polytechnic State University, San Luis Obispo

ROUSE M. 2008. Thermoelectric Cooling Retrieved from www.searchnetworking. techtarget.com

SACE C.F., 2008. Water Management System for Honeydew Melon (Cucumis melo L.) Production Grown in a Hydroponic System Under tropical Greenhouse Condition. Central Luzon State University. Science City of Muñoz.

SACE, C.F & I.C. AGULTO. 2013. Water Management for hydroponic honeydew Melon Production (ISBN 978-3-639-51691-3), Scholars press Publishing, AV Akadmikerlag gnbH &Co. KG, Heinrich- Bocking- Str.6-8,66121, Saarbrucken, Germany.

SACE, C.F., E.P. NATIVIDAD JR. Economic Analysis of an Urban Vertical Garden for Hydroponic Production of Lettuce (*Lactuca Sativa* L.). International Journal of Contemporary applied Sciences (ISSN: 2308-1365) Vol. 2 No. 5, 2015, pp.196-202

SELA G., July 26, 2017 Hydroponic Nutrient solutions. SMART! Fertilizer Management software and an international expert in plant nutrition and irrigation

TAYLOR, R.A., & G.L SOLBREKKEN.(2008). Comprehensive System-Level Optimization of Thermoelectric Devices for Cooling Applications

TINDALL H.D., 1993. Vegetables in the topics. 89-91

TRAVOR S., 2016. Hydroponics- a new method of growing crops without soil. Retrieved November 2018 from http://www.israelagri.com/?CategoryID=484&ArticleID=1269

ZAFAR, S. (2015). "Agricultural Wastes in the Philippines", BioEnergy Consult: Powering Clean Energy in the Future.